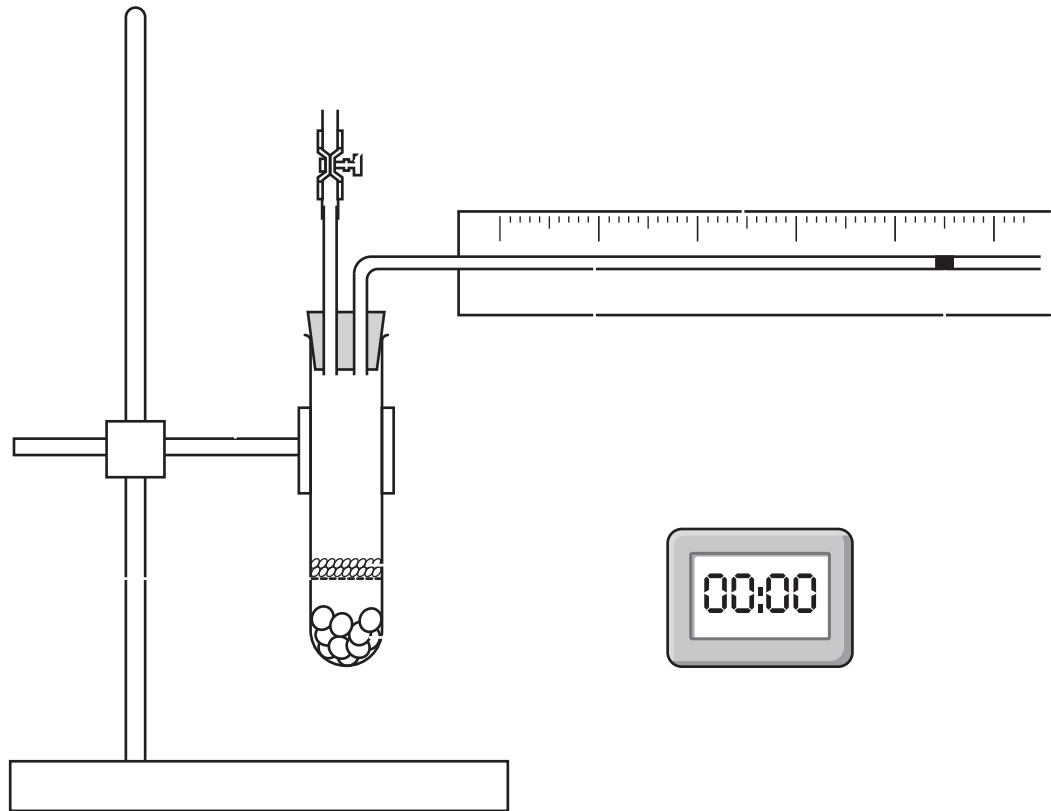


A LEVEL Biology

12. Energy and Respiration Paper 5 (2019-2025)



Classified by Mr. Adeel Ahmad

OCT/NOV 2019 Variant 51

- 1 (a) *Chlorella* is a photosynthetic, single-celled protocist that lives in ponds.

A group of students decided to investigate the effect of temperature on respiration in *Chlorella*.

The students were provided with:

- test-tubes
- metal foil
- flat-bottomed tubes with lids
- glass beakers
- hot water supply
- thermometers
- timer
- pH probe and meter
- hydrogencarbonate indicator solution in a closed container
- a pump connected to an oxygen supply
- a pump connected to a carbon dioxide supply
- a suspension of *Chlorella* with a known cell density.

Carbon dioxide is an acidic gas so it causes the pH of the hydrogencarbonate indicator solution to change. The indicator solution changes colour as pH changes.

Fig. 1.1 shows the range of colours seen in hydrogencarbonate indicator exposed to different carbon dioxide concentrations.

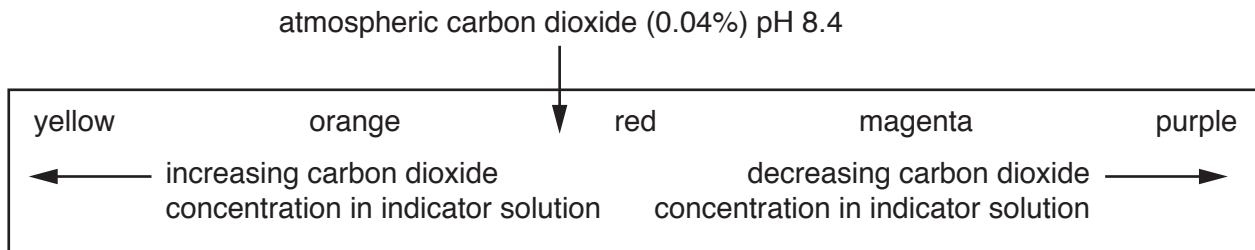


Fig. 1.1

The students made a series of colour standards from yellow to purple by bubbling different volumes of carbon dioxide gas into the indicator solution. The pH was measured with a pH meter for each colour and the solutions were sealed in flat-bottomed tubes labelled with their pH.

The students used the indicator solution to investigate the effect of temperature on carbon dioxide production during respiration in *Chlorella*.

- (i) Suggest a hypothesis that the students could test in this investigation.

.....

 [1]

- (ii) State the independent variable **and** the dependent variable in this investigation. [2]

independent variable

dependent variable

- (iii) Describe how the students could use the apparatus provided to investigate the effect of temperature on carbon dioxide production during respiration in *Chlorella*.

Your method should be set out in a logical order and be detailed enough to let another person follow it.

Details of making the colour standards should **not** be included in your method.

..... [7

- (b) (i) State how the students could calculate the rate of respiration from their results.

.....

.....

..... [1]

- (ii) Sketch a graph on Fig. 1.2 to show the expected result of the effect of temperature on the rate of respiration of *Chlorella*.

Include suitable axes labels and units on your graph.



Fig. 1.2

[3]

- (c) The students carried out a second investigation to determine the effect of cell density on the carbon dioxide production of suspensions of *Chlorella*. All the suspensions were kept at a constant temperature. The students used a probe to measure the production of carbon dioxide in the suspensions of *Chlorella*.

The results are shown in Table 1.1.

Table 1.1

cell density in suspension /arbitrary units	carbon dioxide concentration after 15 min / mg dm ⁻³	rate of carbon dioxide production / mg min ⁻¹
10	2.0	0.13
20	2.4	0.16
30	3.0	0.20
40	4.7	
50	7.4	0.49

- (i) Complete Table 1.1 by calculating the rate of carbon dioxide production for the cell density of 40 arbitrary units. [1]

The students used Pearson's linear correlation to test the hypothesis:

As cell density increases the rate of carbon dioxide production increases.

- (ii) Suggest a null hypothesis for this test.

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 [1]

- (iii) The Pearson's linear correlation coefficient (r) was calculated as 0.85.

State what the calculated value, $r = 0.85$, indicates about the results.

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 [2]

- (iv) The students concluded that the results showed that their hypothesis is correct.

Explain why this conclusion may not be valid.

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 [2]

[Total: 20]

MAY/JUNE 2020 Variant 51

- 1 *Chlorella* is a green, single-celled protist that is photosynthetic. Some students immobilised cells from a culture of this protist using the same method as used for immobilising enzymes.

(a) Outline how the students could immobilise cells of *Chlorella*.

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..... [3]

The students used the respirometer shown in Fig. 1.1 to measure oxygen uptake by the immobilised *Chlorella* cells.

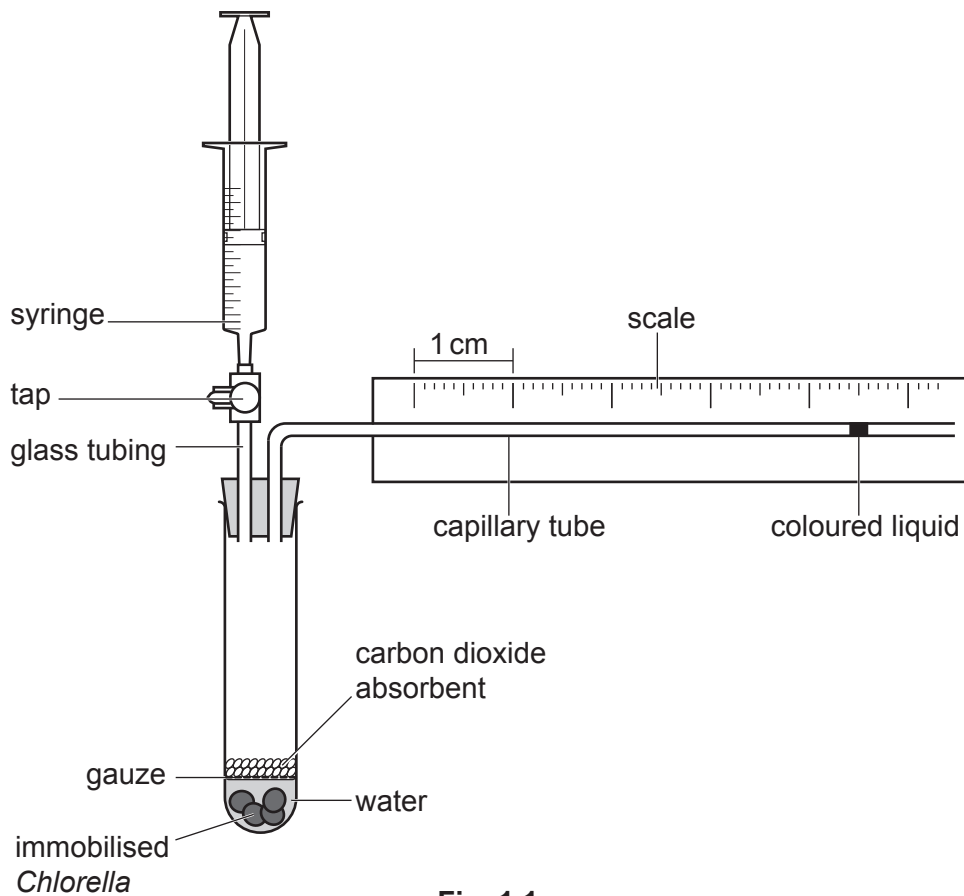


Fig. 1.1

The students used the respirometer to test the hypothesis:

The volume of oxygen taken up by respiration in immobilised *Chlorella* increases with an increase in temperature.

- (b) (i) State the independent variable and the dependent variable in this investigation.

independent variable

.....

dependent variable

.....

[2]

- (ii) The students decided to measure oxygen uptake for 5 minutes using a range of temperatures from 10°C to 50°C.

Discuss whether the range of temperatures used by the students was suitable for their investigation.

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..... [2]

- (iii) Describe a method by which the students could set up the respirometer **and** use it to test their hypothesis:

The volume of oxygen taken up by respiration in immobilised *Chlorella* increases with an increase in temperature.

Your method should be set out in a logical order and be detailed enough to let another person follow it.

Details of immobilising *Chlorella* are **not** required.

..... [7

- (c) The students calculated the oxygen uptake for each temperature.

Their results are shown in Table 1.1.

Table 1.1

temperature / °C	10	20	30	40	50
oxygen uptake / mm ³	200	400	800	750	680

- (i) Outline how the students calculated the volume of oxygen uptake.

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- (ii) State **and** explain **two** conclusions about the trends shown by these results.

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..... [2]

[Total: 18]

MAY/JUNE 2020 Variant 52

- 1 (a) Woodlice are small invertebrates that live in cool, damp places under wood and stones.

Some students determined the respiration rate of woodlice at different temperatures.

Fig. 1.1 shows a single woodlouse.

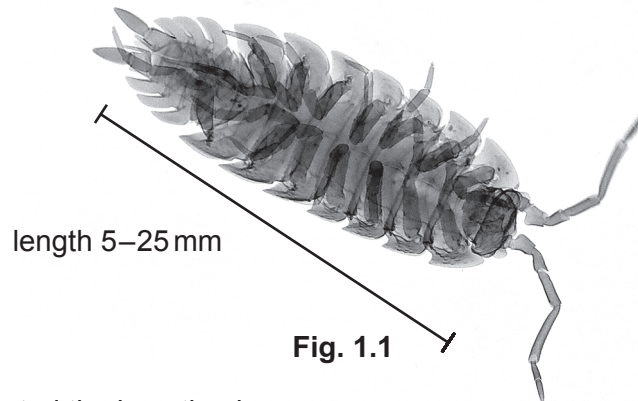


Fig. 1.1

The students tested the hypothesis:

For each 10°C increase in temperature the volume of oxygen absorbed will double.

Fig. 1.2 shows the respirometer that the students used.

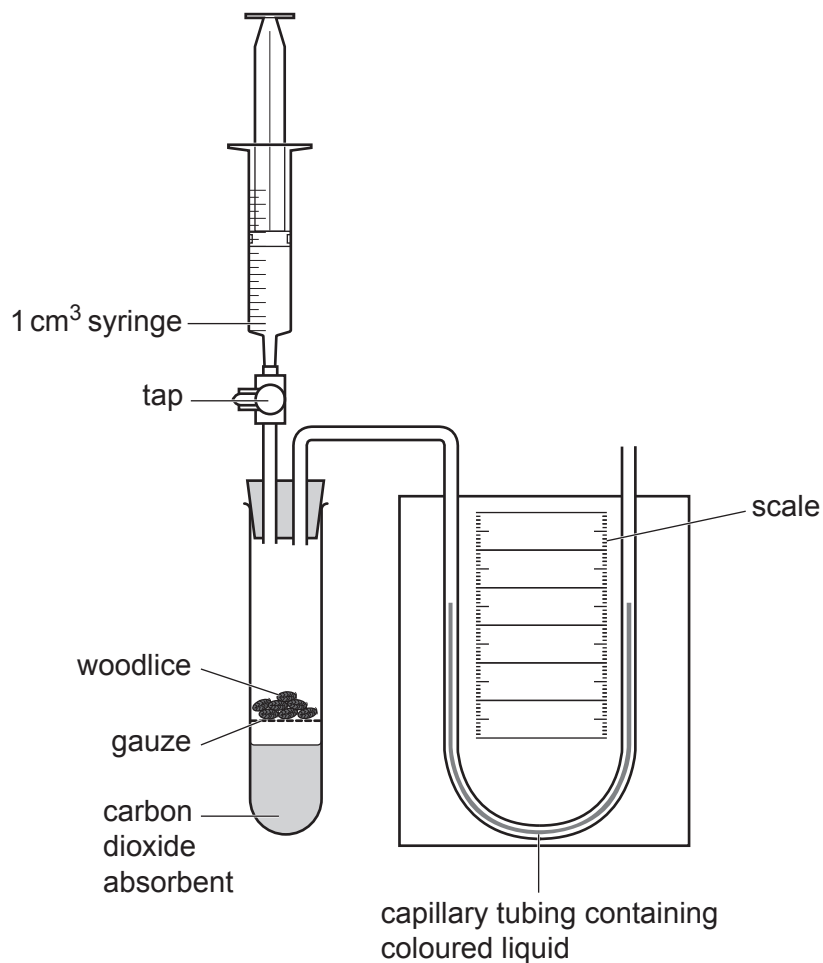


Fig. 1.2

- (i) State the independent variable and the dependent variable in this investigation.

independent variable

.....

dependent variable

.....

[2]

- (ii) The students decided to measure oxygen uptake for 5 minutes using a range of temperatures from 5 °C to 35 °C.

Suggest why the students chose this range of temperatures **and** suggest a suitable interval that the students should use.

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..... [2]

- (iii) State a suitable control for this investigation.

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..... [1]

- (iv) State why the carbon dioxide absorbent solution was placed in the tube.

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..... [1]

- (v) Suggest **one** variable in this investigation that **cannot** be standardised.

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..... [1]

- (b) (i)** Describe a method by which the students could set up the respirometer **and** use it to test their hypothesis:

For each 10°C increase in temperature the volume of oxygen absorbed will double.

Your method should be set out in a logical order and be detailed enough to let another person follow it.

[7]

- (ii) Each 1 cm length of the capillary tubing containing coloured liquid in Fig. 1.2 has a volume of 10 mm^3 .

Describe how the students could use their results to calculate the rate of respiration for each temperature from their results.

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..... [3]

- (iii) Use the axes in Fig. 1.3 to show the expected shape of the curve if the hypothesis is correct.

For each 10°C increase in temperature the volume of oxygen absorbed will double.

Include the labels and units for each axis.



Fig. 1.3

[3]

- (c) The students used the same apparatus to determine the output of carbon dioxide by the woodlice at 35°C . The students used this result and the result for oxygen uptake at 35°C to calculate the respiratory quotient (RQ).

The RQ was calculated as 0.95.

State what conclusion can be made from this RQ value.

.....

..... [1]

[Total: 21]

MAY/JUNE 2020 Variant 53

- 1 (a) Some students decided to find the respiratory quotient (RQ) of germinating pea seeds.

Pea seeds germinate best at temperatures between 13 °C to 18 °C.

Table 1.1 shows the main biological molecules in pea seeds that could be used to release energy for seed germination.

Table 1.1

biological molecule	g per 100 g of dry mass
carbohydrate	68
protein	25
fat	1

- (i) Predict the RQ value for these seeds in aerobic conditions.

..... [1]

The students used the respirometer shown in Fig. 1.1.

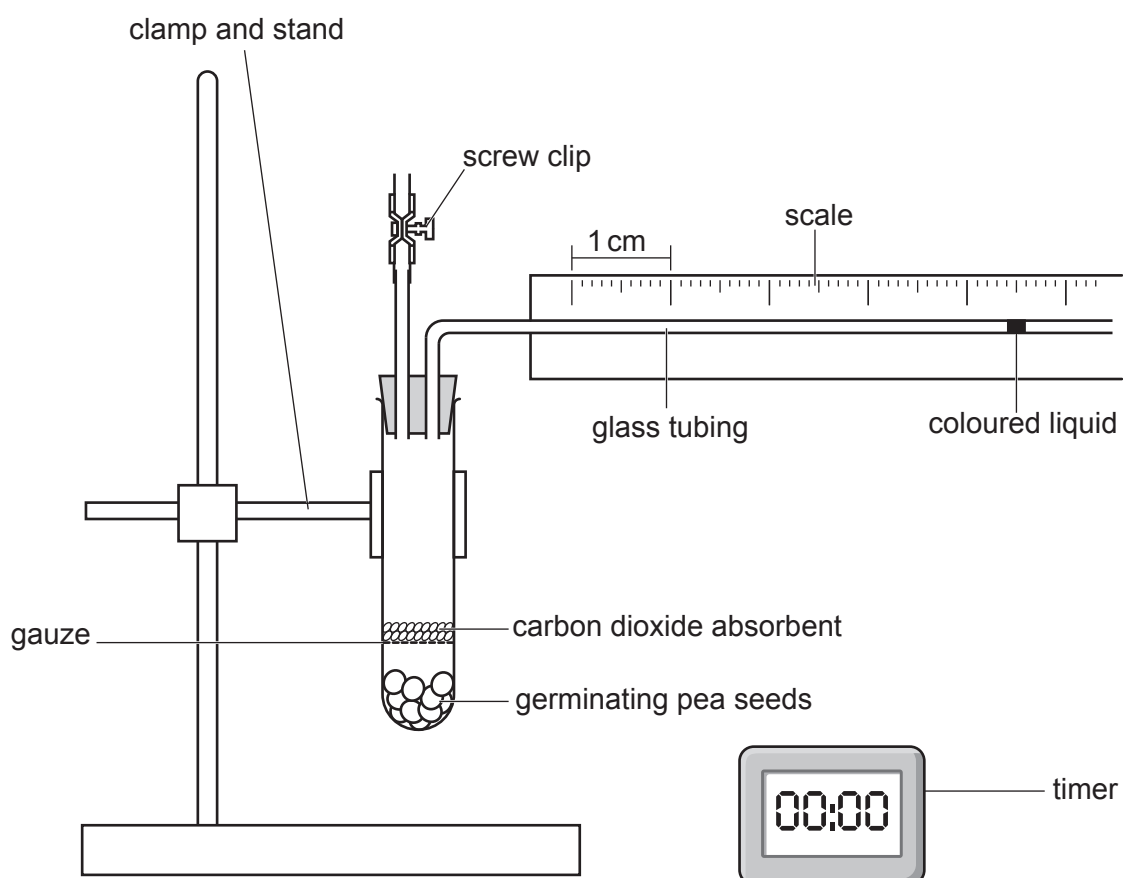


Fig. 1.1

- (ii) Describe how the students could set up the respirometer **and** use it to make the measurements needed to calculate the RQ of germinating pea seeds.

Your method should be set out in a logical order and be detailed enough to let another person follow it.

[7]

- (b) Describe how the students should process their results to find the volumes of gases needed to calculate the RQ of germinating pea seeds.

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..... [3]

- (c) (i) The students predicted that peas could also respire in anaerobic conditions, producing alcohol and carbon dioxide.

Outline how the students could use the respirometer in Fig. 1.1 in anaerobic conditions to find out if their prediction was correct.

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..... [3]

- (ii) Table 1.2 shows the distance moved by the coloured liquid in anaerobic conditions in five different trials.

Table 1.2

trial	1	2	3	4	5
distance moved / mm	25	38	21	27	23

The students calculated a mean from the results in Table 1.2. They did not include one of the results in their calculation.

Identify the result that the students did not use **and** explain why they did not use it.

.....
 [1]

[Total: 15]

OCT/NOV 2021 Variant 51

- 1 Baker's yeast, *Saccharomyces cerevisiae*, has two metabolic pathways for the production of ATP, aerobic respiration and fermentation. Oxygen is **not** used in fermentation.

These pathways are summarised in Fig. 1.1.

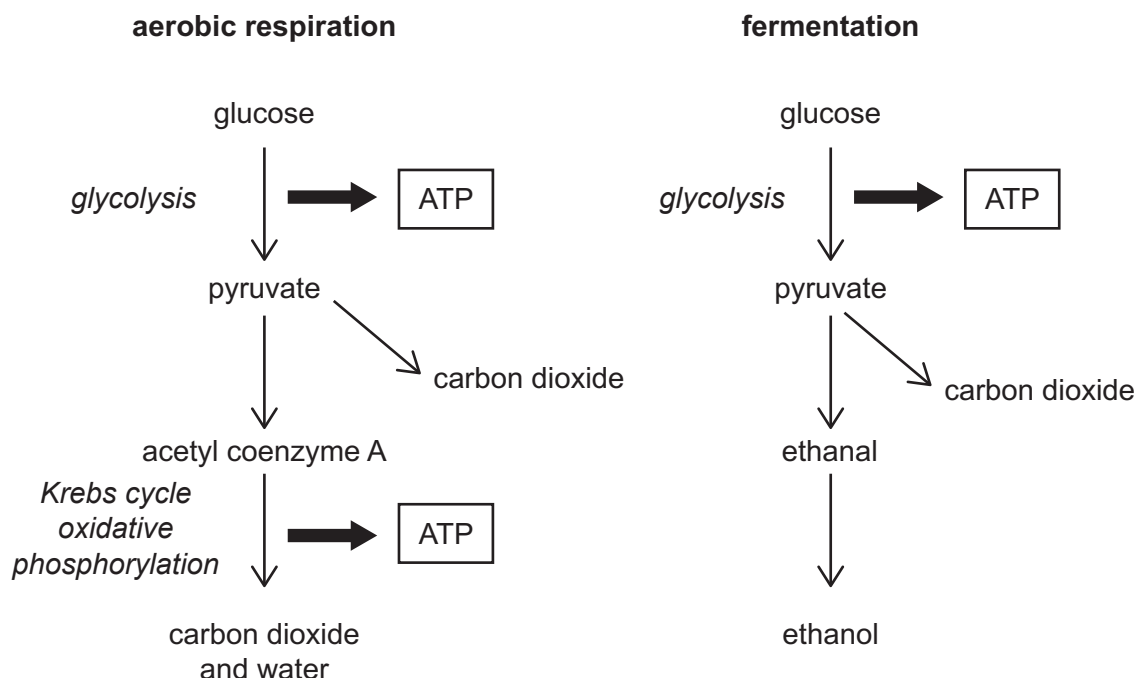


Fig. 1.1

Some students were researching details of the respiration of yeast. In their research, the students found information about the Crabtree effect. This effect occurs when yeast is kept in high concentrations of glucose. The yeast gains sufficient ATP from substrate-linked phosphorylation during glycolysis. Yeast does not carry out the Krebs cycle or oxidative phosphorylation and therefore does not use oxygen.

The students wanted to investigate the effect of temperature on the activity of yeast and decided to use yeast solutions in which the yeast obtained all of its ATP by fermentation.

- The students made a suspension of yeast from 1 g of dried yeast and 25 cm³ of water.
- The suspension was left for 2 hours at 20 °C.
- After 2 hours, 25 cm³ of glucose solution was added to the yeast suspension and the mixture was stirred.
- Some of the mixture was added immediately to the apparatus shown in Fig. 1.2.

The students measured the volume of carbon dioxide produced by yeast fermentation.

3

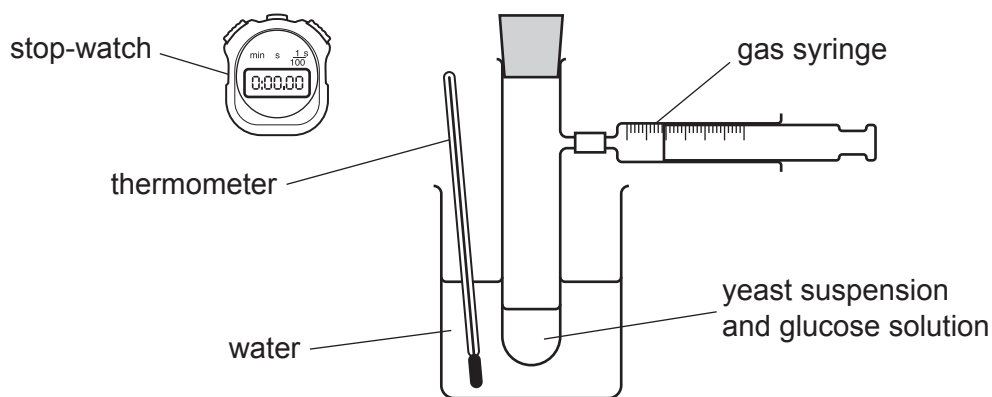


Fig. 1.2

- (a) (i) State the independent variable **and** the dependent variable in this investigation.

independent variable

.....

dependent variable

.....

[2]

- (ii) Explain why the students stirred the mixture of yeast and glucose before adding it to the tube in the apparatus in Fig. 1.2.

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..... [1]

- (iii) Describe a method using the apparatus, set up as shown in Fig. 1.2, that the students could use to find the temperature at which yeast carries out fermentation at its maximum rate.

Your method should be set out in a logical order and be detailed enough for another person to follow.

You should **not** include details of how to make the yeast suspension or how to set up the apparatus.

..... [7

- (iv) Complete the sketch graph to predict the results that you would expect from the method that you have given in part (iii). Include axes labels with units in your answer.



[2]

- (b) Scientists have discovered that some other species of yeast show the Crabtree effect.

The Crabtree effect means that in high concentrations of glucose **and** with oxygen present, pyruvate is not metabolised in mitochondria so aerobic respiration does not occur.

Yeast species that are able to maintain their levels of ATP production when conditions suddenly change and **no** oxygen is available show the Crabtree effect.

An investigation compared *S. cerevisiae* with the yeast *Candida tropicalis* to see if this other species also shows the Crabtree effect.

Three flasks containing suspensions of *S. cerevisiae* in a growth medium were initially kept in different conditions (conditions for growth).

After a set time, the yeast in each flask was transferred to a flask containing a fresh medium with high glucose concentration and **no** oxygen (experimental conditions). All other conditions were standardised.

The same procedure was repeated for *C. tropicalis*.

The conditions for growth and the experimental conditions in the flasks are summarised in Table 1.1.

Table 1.1

flask	conditions for growth	experimental conditions
flask 1	high glucose concentration with no oxygen	high glucose concentration with no oxygen
flask 2	high glucose concentration with oxygen	high glucose concentration with no oxygen
flask 3	water (no glucose) with oxygen	high glucose concentration with no oxygen

Samples taken from the flasks kept in the experimental conditions were put into the apparatus shown in Fig. 1.2 to measure the volume of carbon dioxide produced by the two yeast species.

The results are shown in Fig. 1.3.

The final volume of carbon dioxide produced by the sample of yeast from flask 1 at 30 minutes is shown as a maximum volume of 100% in Fig. 1.3. All other volumes were calculated as a proportion of this maximum. This allows a direct comparison to be made between the two species.

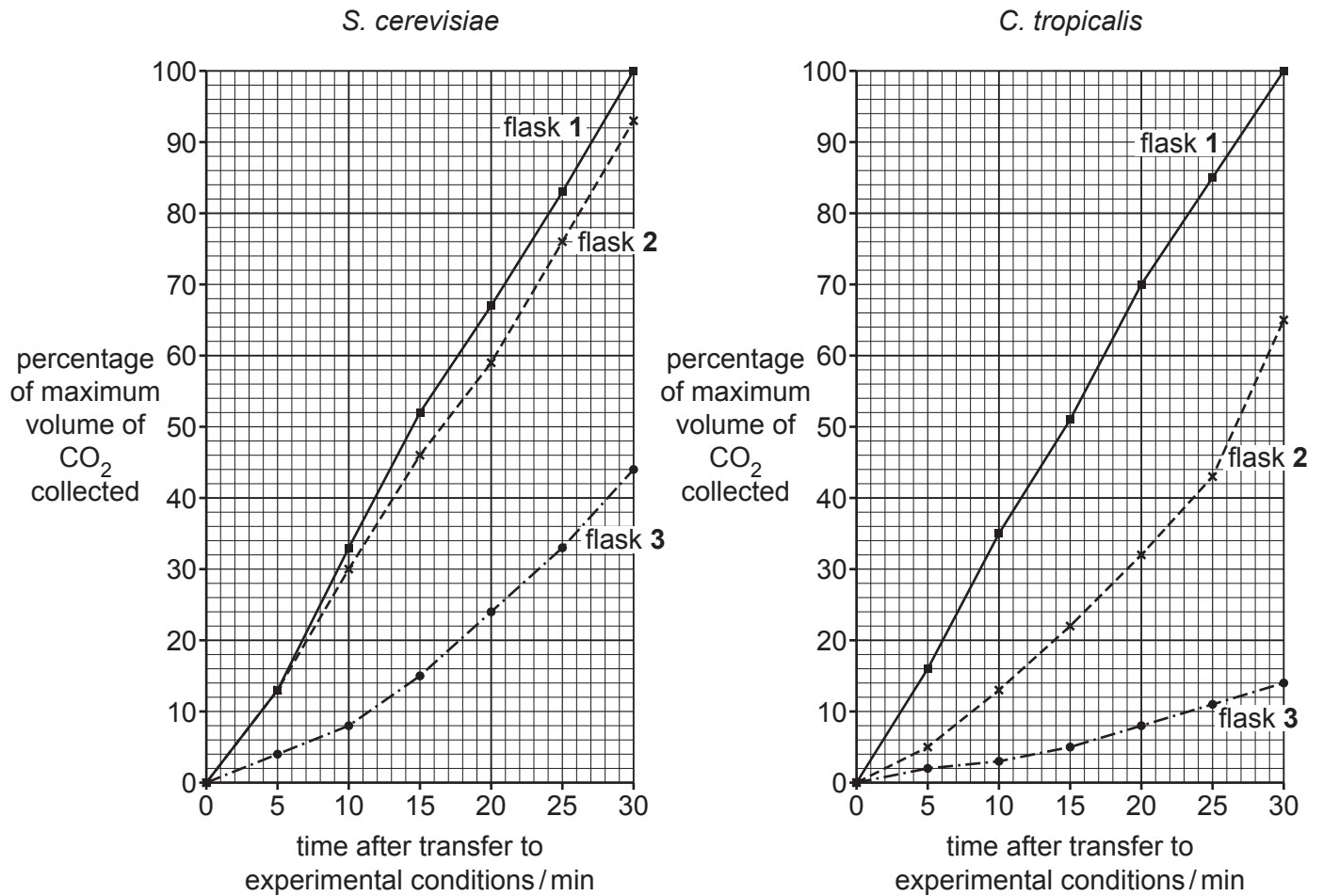


Fig. 1.3

State **and** explain the evidence in Fig. 1.3 that supports the idea that *C. tropicalis* does **not** show the Crabtree effect.

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..... [3]

[Total: 15]

OCT/NOV 2021 Variant 52

- 1 Some students researched how yeast, *Saccharomyces cerevisiae*, is used in the food industry. The students found that in different manufacturing processes yeast is provided with different types of sugar. These sugars are either monosaccharides or disaccharides.

The students decided to compare the effect of supplying yeast with glucose or with maltose.

Glucose is a monosaccharide. Maltose is a disaccharide composed of two glucose molecules joined by a glycosidic bond.

- The students made a standard yeast suspension using 100g of dried yeast and 1 dm³ of deionised water.
- The suspension was left at 20°C for two hours. During this time the yeast became active.
- After two hours the yeast culture was divided into two samples.
- Sample **A** was provided with glucose and sample **B** was provided with maltose.
- The apparatus shown in Fig. 1.1 was set up for each sample separately.

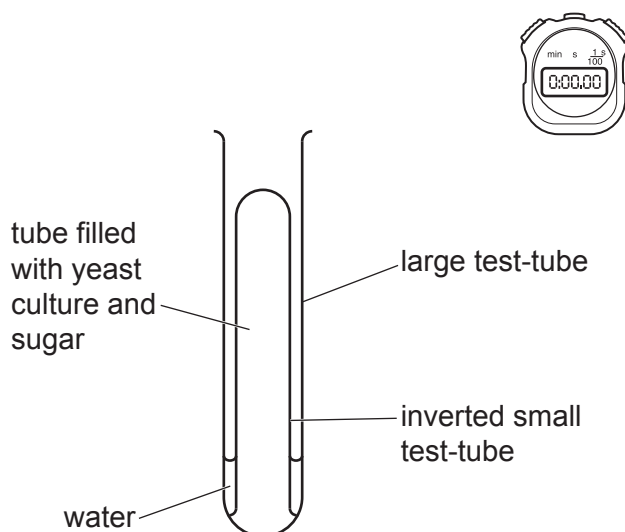


Fig. 1.1

- As the yeast respired, gas collected at the top of the small test-tubes, as shown in Fig. 1.2.

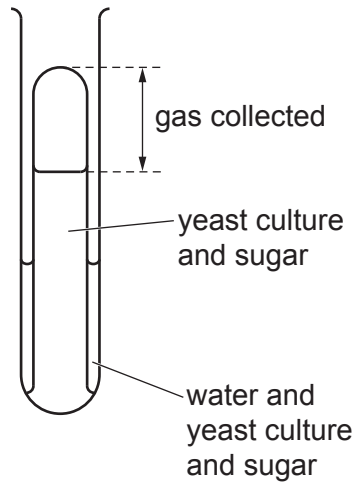


Fig. 1.2

The students used the apparatus to test the hypothesis:

Yeast has a higher rate of respiration when supplied with glucose than when supplied with maltose.

- (a) (i) State the independent variable **and** the dependent variable in this investigation.

independent variable

.....

dependent variable

.....

[2]

- (ii) The students stirred the yeast suspension before dividing it into the two samples.

Explain why it is important to stir the suspension.

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..... [1]

- (iii) Describe a method using the apparatus set up as shown in Fig. 1.1 that the students could use to test their hypothesis.

Your method should be set out in a logical order and be detailed enough for another person to follow.

You should **not** include details of how to make the yeast suspension or how to set up the apparatus.

[7]

- (b) Other students used a gas syringe to measure the volume of gas produced when a suspension of yeast was supplied with glucose or maltose.

Fig. 1.3 shows their results.

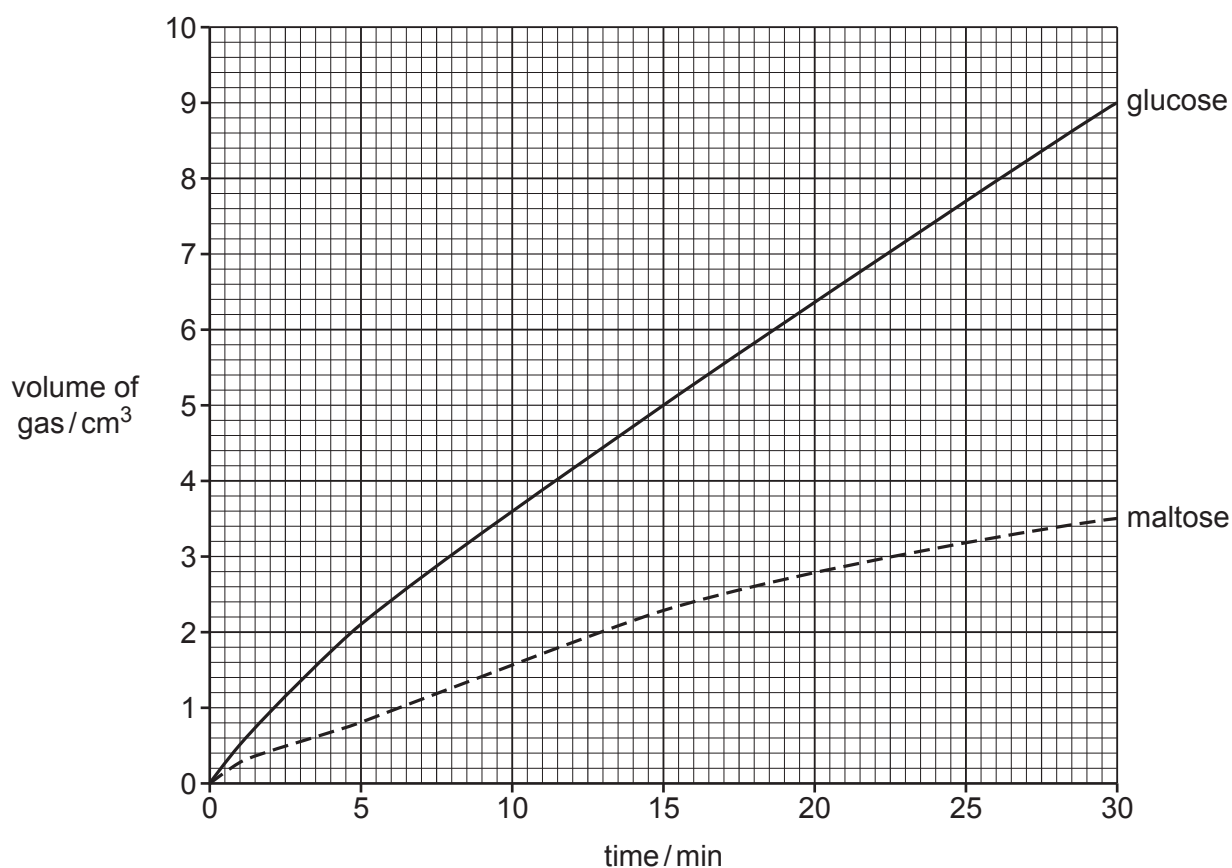


Fig. 1.3

- (i) State how the students could calculate the rate of respiration from the results shown in Fig. 1.3.

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..... [1]

- (ii) State **and** explain the conclusions that can be made for the results in Fig. 1.3.

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..... [3]

- (c) When the students evaluated their method they thought that they could measure the change in pH in the yeast suspension as the gas produced by yeast is carbon dioxide.

One student suggested using an indicator solution and colour chart. Another student suggested using a pH meter.

Suggest the advantages of using a pH meter rather than an indicator solution and colour chart.

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..... [3]

[Total: 17]

MARCH 2023

- 1 Potatoes are underground organs made by the potato plant, *Solanum tuberosum*.

Fig. 1.1 shows a potato plant.

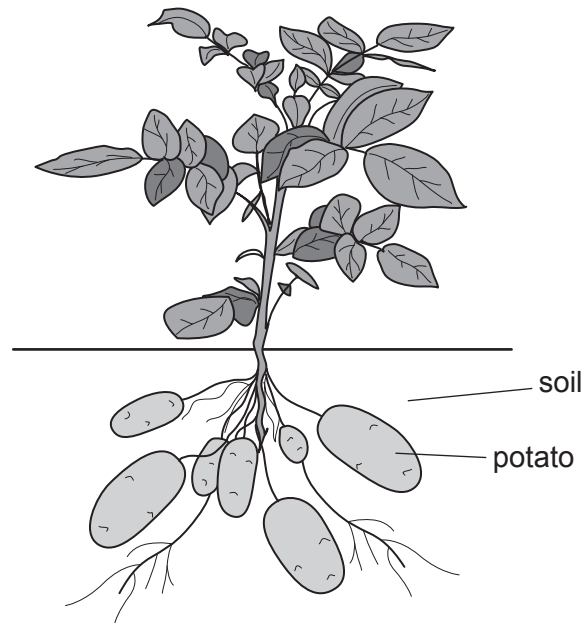


Fig. 1.1

Potatoes contain high quantities of starch and are a popular food. After harvesting, potatoes are stored. During storage, the starch content of potatoes gradually decreases due to the breakdown of starch molecules into glucose.

A glucose assay using a Benedict's test and a colorimeter can be used to determine the concentration of glucose in potatoes.

The glucose assay uses these steps:

- The outer skin is removed from a potato.
- The potato is cut into small pieces that are then ground into a pulp using a mortar and pestle.
- The potato pulp is filtered to remove most of the solids and obtain potato juice.
- Excess Benedict's solution is added to the potato juice.
- The mixture is heated in a water-bath at 90 °C for five minutes. During this five-minute period, copper ions (Cu^{2+}) in the Benedict's solution react with glucose in the potato juice to form an insoluble precipitate.
- The mixture is filtered to remove the precipitate. The filtrate, which is blue, contains copper ions that did not react with the glucose in the potato juice while the mixture was being heated.
- A sample of the blue filtrate is transferred to a colorimeter tube (cuvette).
- A colorimeter is used to measure the absorbance of the blue filtrate.
- A calibration curve is used to determine the glucose concentration of the potato juice from the measurement of absorbance.

Fig. 1.2 shows one type of colorimeter.



Fig. 1.2

A clean colorimeter tube containing the sample to be tested is placed in the colorimeter. Light is passed through the sample and the absorbance of light by the sample is measured.

- (a) (i) Outline how colorimeters should be prepared **before** carrying out measurements on samples so that correct absorbance readings in the glucose assay are obtained.

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..... [1]

To determine the concentration of glucose in potato juice using the glucose assay, a calibration curve needs to be produced. This involves using the glucose assay to obtain absorbance readings for standard glucose solutions of known concentrations.

- (ii) A student was given a 2.0% stock solution of glucose from which to prepare a range of standard glucose solutions of known concentrations.

State the glucose concentrations the student could use to produce a calibration curve **and** describe how **20 cm³** of each solution should be prepared by **proportional** dilution of the 2.0% stock solution of glucose.

You may use a table to show your answer.

glucose concentrations to use:

how to prepare:

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[3]

- (iii) Sketch, on Fig. 1.3, a graph of the expected calibration curve that the student would obtain.

Include the axis labels.



Fig. 1.3

[2]

- (b)** The student decided to investigate the effect of storage time on the glucose concentration of potatoes.

- (i) Identify the **dependent** variable in this investigation.

..... [1]

- (ii) The student was provided with freshly harvested potatoes, standard laboratory apparatus and a colorimeter.

Describe a method, using the glucose assay, that the student could use to investigate the effect of **storage time** on the glucose concentration of potatoes.

Your method should be set out in a logical order and be detailed enough to allow another person to follow it.

Details of how to carry out the glucose assay and how to prepare and use the colorimeter should **not** be included.

[6]

When potatoes are cooked at high temperatures to make potato chips, glucose and amino acids react together. This reaction is known as the Maillard reaction and is responsible for the orange-brown colour of potato chips.

When glucose reacts with the amino acid asparagine, acrylamide is made.

This reaction is shown in Fig. 1.4.

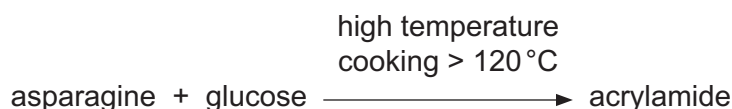


Fig. 1.4

Low concentrations of acrylamide are produced when potatoes are cooked at high temperatures to make potato chips. High concentrations of acrylamide are toxic to humans and can increase the risk of certain cancers developing.

Exposing raw potatoes to gamma radiation decreases the acrylamide concentration of potato chips.

Some scientists investigated the effect of gamma radiation on the composition of raw potatoes.

- Four bags of one variety of potato were each exposed to a different dose of gamma radiation: 0 J kg^{-1} , 50 J kg^{-1} , 100 J kg^{-1} and 150 J kg^{-1} .
- Three samples of raw potatoes from each bag were then analysed chemically to determine the concentrations of glucose, protein and volatile nitrogen compounds as a percentage of dry mass. Volatile nitrogen compounds are present in potatoes due to the breakdown of some proteins and amino acids, such as asparagine.
- Statistical tests were carried out on the data to assess whether the gamma radiation dose affected the concentrations of glucose, protein and volatile nitrogen compounds in the raw potatoes.

Data from the chemical analysis and the statistical tests are shown in Table 1.1.

Table 1.1

gamma radiation dose /J kg ⁻¹	mean composition of the raw potato sample as a percentage of dry mass		
	glucose	protein	volatile nitrogen compounds
0	0.83	10.92	1.14×10^{-2}
50	0.86	11.04	0.75×10^{-2}
100	0.83	10.08	0.68×10^{-2}
150	0.88	10.96	0.40×10^{-2}
statistical significance of differences between raw potato samples exposed to different doses of gamma radiation	not significant at $p < 0.05$	not significant at $p < 0.05$	significant at $p < 0.05$

- (c) The scientists suggested that gamma radiation reduces the acrylamide content of potato chips by affecting asparagine.

Explain how the information provided **and** the data in Table 1.1 support this view.

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..... [2]

(d) In a further study, the scientists investigated whether gamma radiation **and** a hot water treatment reduce the acrylamide concentration of potato chips.

- Four bags of one variety of potato were each exposed to a different dose of gamma radiation: 0 J kg^{-1} , 50 J kg^{-1} , 100 J kg^{-1} or 150 J kg^{-1} .
- After exposure to gamma radiation, the potatoes from each bag were cut into $1 \text{ cm} \times 1 \text{ cm} \times 5 \text{ cm}$ blocks.
- Potato blocks from each bag were given two different treatments.

treatment 1: 100 g of potato blocks were cooked in 1 dm^3 of sunflower oil at 170°C for five minutes.

treatment 2: 100 g of potato blocks were heated in 500 cm^3 water at 85°C for five minutes, removed from the water and then cooked in 1 dm^3 of sunflower oil at 170°C for five minutes.

The scientists measured the acrylamide concentration of the potato chips after these treatments.

This procedure was repeated a further five times to allow statistical tests to be carried out on the results.

The results of the investigation are summarised in Table 1.2.

Table 1.2

gamma radiation dose J kg^{-1}	mean acrylamide concentration of potato blocks $\mu\text{g kg}^{-1}$	
	treatment 1	treatment 2
0	4551	1768
50	3629	1487
100	3310	1339
150	2073	1010

- (i) Using the data in Table 1.2, calculate the percentage decrease in the mean acrylamide concentration of potato blocks given treatment 2 compared to potato blocks given treatment 1, for a gamma radiation dose of 0 J kg^{-1} .

Show your working.

percentage decrease = [2]

The results in Table 1.2 are shown as a graph in Fig. 1.5. Error bars have been added to show 95% confidence intervals (95% CI).

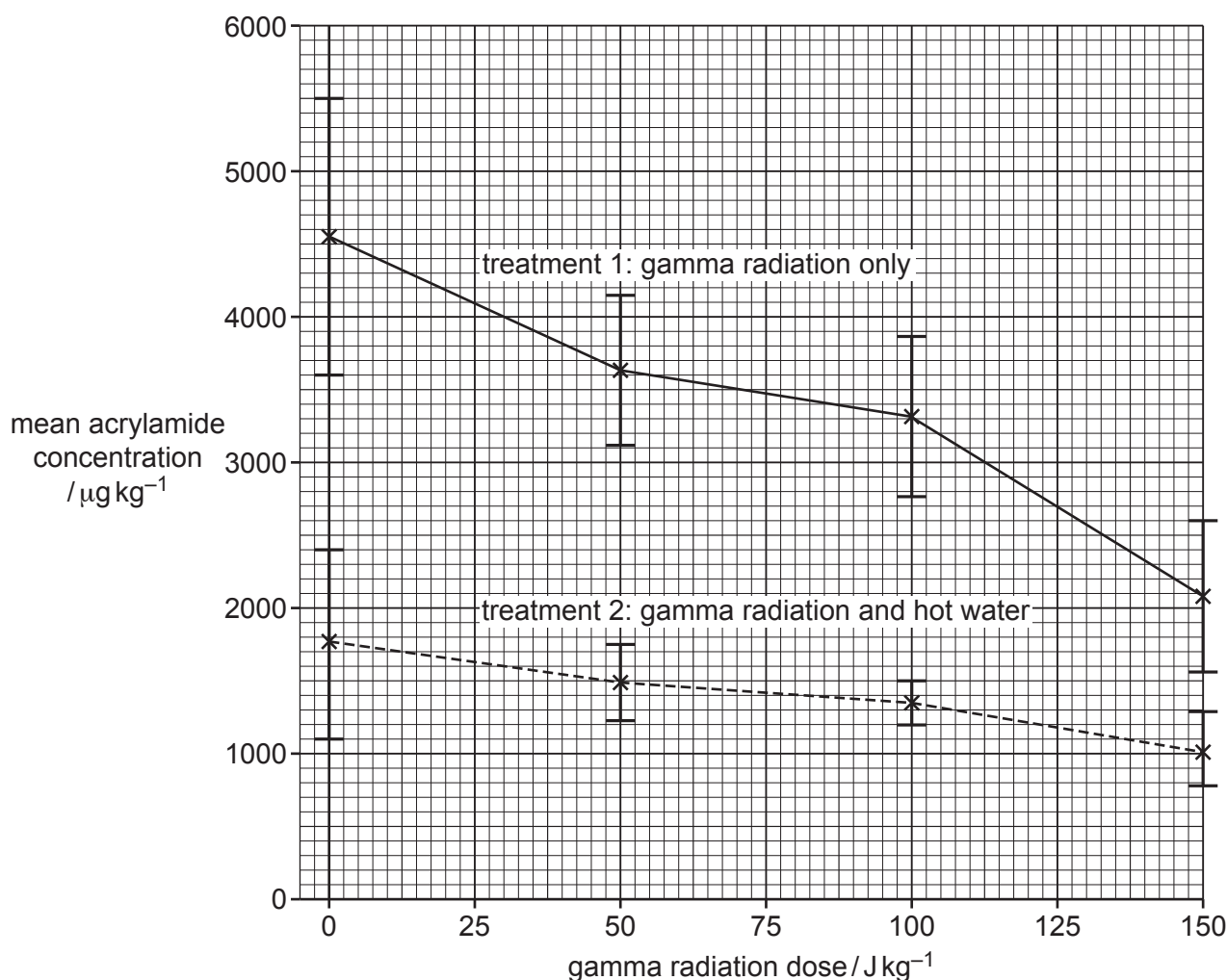


Fig. 1.5

The scientists concluded that a combination of gamma radiation **and** hot water treatment is the most effective way to reduce the acrylamide concentration of potato chips.

- (ii) Explain how the information shown in Table 1.2 and Fig. 1.5 supports, or does **not** support, this conclusion.

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..... [3]

[Total: 20]

MAY/JUNE 2023 Variant 51

1.(d) In a different investigation, the student determined the effect of hydrogen peroxide concentration on the activity of catalase in yeast.

- 5 cm³ hydrogen peroxide solution was placed in a test-tube at 25 °C.
- 0.2g dried yeast was added to the test-tube, so that the yeast cells formed a suspension in the hydrogen peroxide solution.
- A gas syringe was quickly connected to the test-tube using a bung and delivery tube, as shown in Fig. 1.6.
- The volume of gas collected after one minute was measured.

Fig. 1.6 shows the apparatus used by the student.

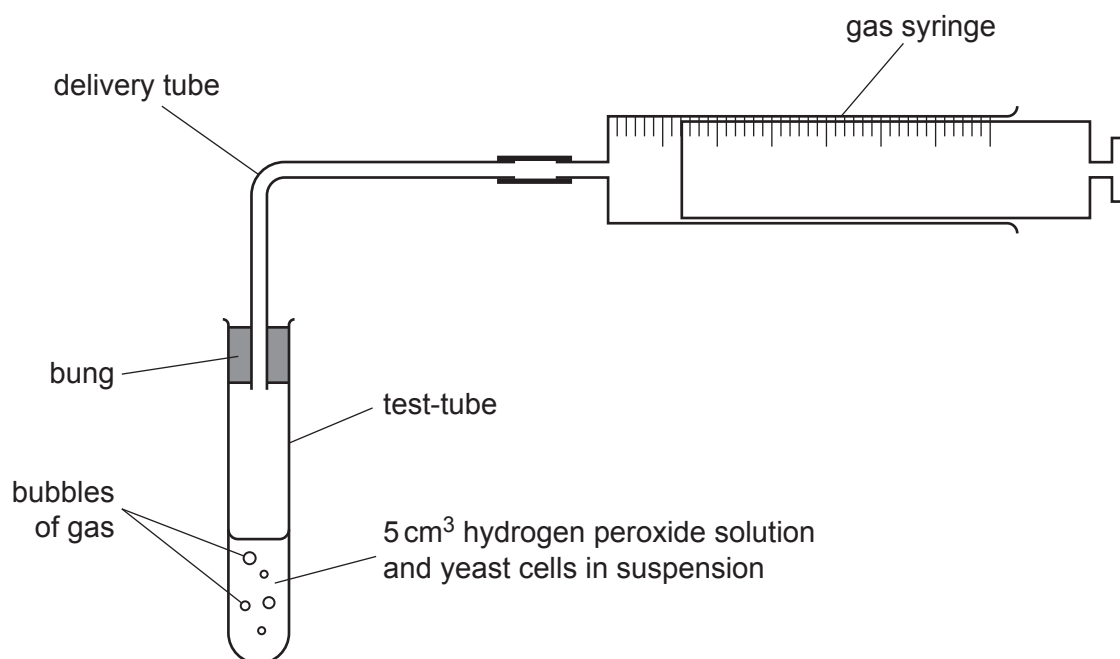


Fig. 1.6

(i) Identify the **dependent** variable in this investigation.

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..... [1]

- (ii) To investigate the effect of hydrogen peroxide concentration on the activity of catalase in yeast, the student first prepared a range of known concentrations of hydrogen peroxide.

The student was given a 6.0% stock solution of hydrogen peroxide. The student decided to use the stock solution to make hydrogen peroxide solutions with concentrations of 3.0%, 3.6%, 4.8% and 5.4%.

The student made 50 cm³ of each solution.

Complete Table 1.1 to show how these solutions could be made by **proportional dilution** of the 6.0% stock solution of hydrogen peroxide.

Table 1.1

percentage concentration of hydrogen peroxide	volume of stock solution /cm ³	volume of /cm ³
3.0		
3.6		
4.8		
5.4		

[2]

Use this space for your working.

(iii) Fig. 1.7 shows the results of the investigation.

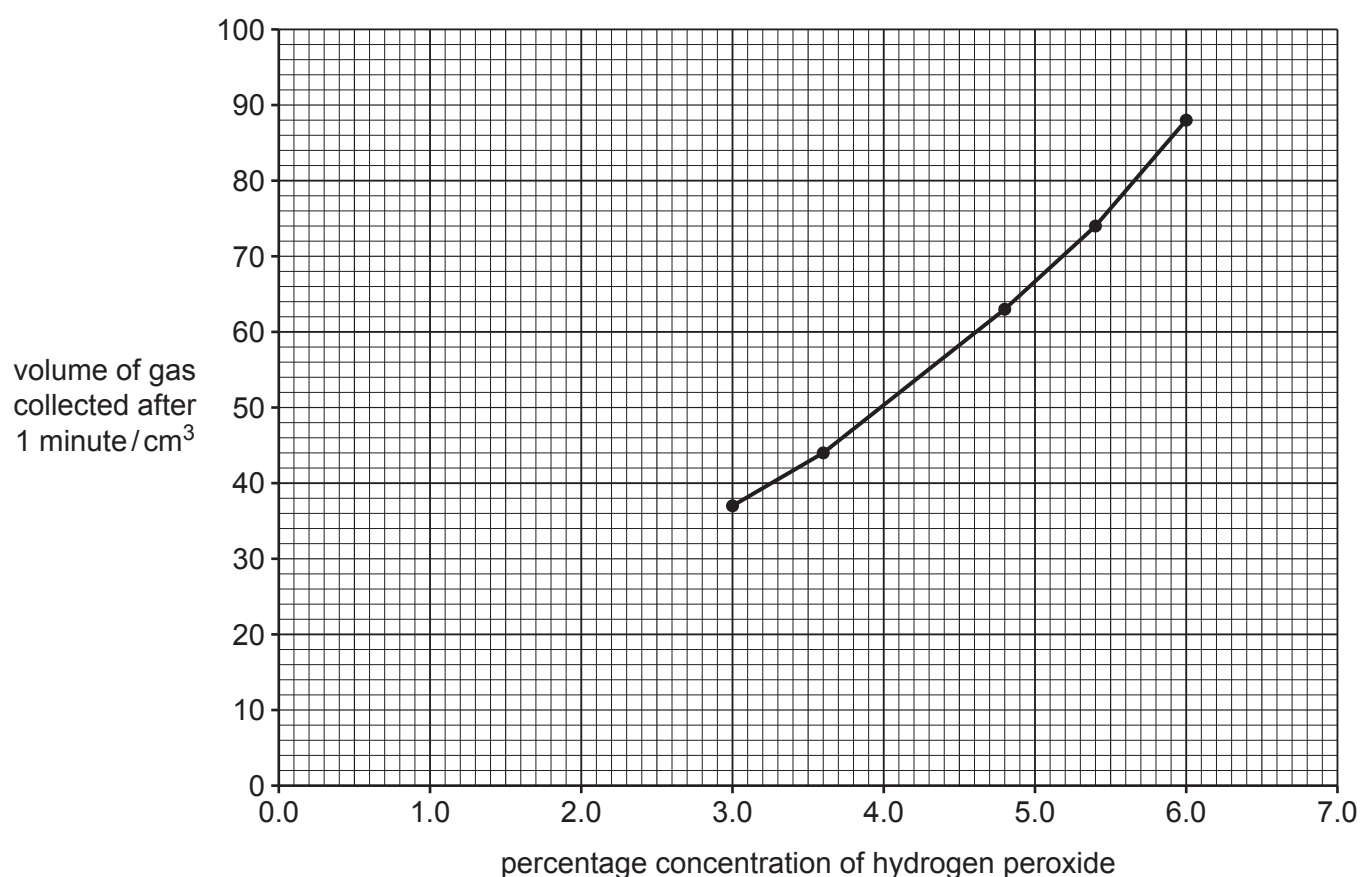


Fig. 1.7

The student made two conclusions:

- As the concentration of hydrogen peroxide increases, the volume of oxygen produced after one minute increases.
- The V_{max} of catalase is 88 cm³.

Use the information shown in Fig. 1.7 to evaluate these conclusions.

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..... [3]

[Total: 15]

OCT/NOV 2023 Variant 51

- 1 Fruits in the diet can be a source of vitamins, such as vitamin C and vitamin A, which are important in maintaining good health.

Vitamin A is a group of molecules that includes retinol and retinal.

Vitamin C is an organic acid known as ascorbic acid.

Ripening occurs in fruit when molecular changes cause an increase in sugar content, colour changes and softening of the fruit, over time.

Ascorbic acid is found in plant cells. The fruits of many plants have high concentrations of ascorbic acid.

A student planned to investigate how ascorbic acid concentration changes with ripeness in the fruit of the apple tree, *Malus domestica*.

The fruit of *M. domestica* (apples) are shown in Fig. 1.1.



Fig. 1.1

- (a) The student removed an apple that was 5 cm in diameter from a tree. The student measured the sugar content of the apple, which was low. This indicated that the apple was at the early stages of ripening (unripe).

For the investigation, the student decided to select apples from trees when each apple was 5 cm in diameter.

The student assumed that the ripeness of each apple would increase each day after it had been picked from a tree.

- (i) Suggest why the diameter of the apples selected may **not** give accurate estimates of ripeness.

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 [1]

- (ii) Describe an improvement to the method for selecting the apples that would give more accurate estimates of ripeness.

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..... [1]

- (b) The student researched how ascorbic acid concentration changes with ripeness in the fruit of other species.

Based on this research, the student predicted that ascorbic acid concentration in apples will:

- be lowest in unripe apples when they are first picked from the tree
- increase over several days and peak in partially ripe apples
- decrease slightly in later days as the apples become fully ripe.

Sketch a line graph below, including labelled axes, to show the predicted results.



[2]

- (c) The student used the redox indicator DCPIP to investigate how ascorbic acid concentration changes as the apples ripen.

The student tested the ascorbic acid concentration of the apples at intervals from the time they were taken from the tree until the apples were fully ripe.

For each test, the student prepared an apple extract solution and reacted this with a DCPIP solution of standardised concentration.

- (i) The student was provided with a 0.01 mol dm^{-3} stock solution of DCPIP.

After preliminary research, the student decided to dilute the stock solution to prepare a $0.0005 \text{ mol dm}^{-3}$ DCPIP solution to use in the experiment.

The student used two steps to dilute the stock solution to the $0.0005 \text{ mol dm}^{-3}$ DCPIP solution.

Complete the description of the two steps for the dilution by adding the correct values to the sentences.

step 1

The student mixed 10 cm^3 of 0.01 mol dm^{-3} DCPIP stock solution with cm^3 of distilled water to produce solution **A**. Solution **A** had a concentration of $0.001 \text{ mol dm}^{-3}$.

step 2

The student then mixed cm^3 of solution **A** with 50 cm^3 of distilled water to produce the $0.0005 \text{ mol dm}^{-3}$ DCPIP solution.

[2]

(ii) DCPIP changes colour from blue to colourless when it is reduced by ascorbic acid.

- The volume of DCPIP that can be reduced by ascorbic acid is a measure of the concentration of ascorbic acid present in a solution.
- When all the ascorbic acid present in a solution has reacted with DCPIP, any more DCPIP that is added will remain blue.

The student had access to standard laboratory equipment and a burette.

DCPIP solution can be added to a burette and released one drop at a time by turning a tap.

Fig. 1.2 shows a burette set up for this investigation.

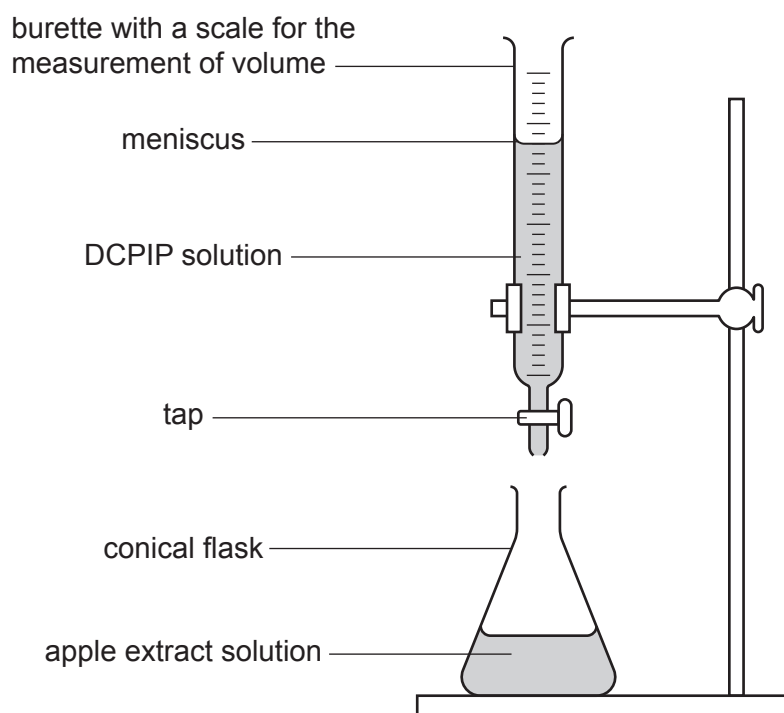


Fig. 1.2

MAY/JUNE 2025 Variant 54

- 2 A student investigated the oxygen consumption of isolated mitochondria under different conditions.

Mitochondria were isolated by crushing liver cells in ice cold buffer and filtering to remove cell debris. The filtrate was centrifuged to separate the mitochondria. The mitochondria were suspended in ice cold buffer.

- (a) State **one** reason for keeping the mitochondria in cold buffer solution during isolation.

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 [1]

Fig. 2.1 shows the apparatus used to measure the oxygen consumption of the isolated mitochondria.

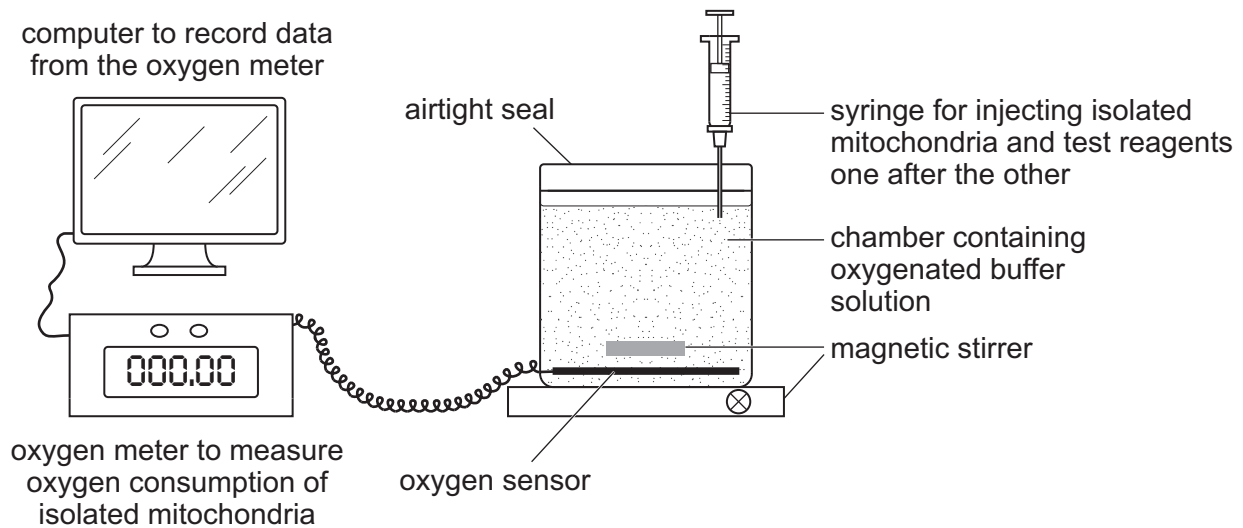


Fig. 2.1

The apparatus was used as follows.

- The apparatus was set up as shown in Fig. 2.1 and left for 1 minute to equilibrate.
- At 1 minute, a standard volume of mitochondria in buffer solution was injected through the seal.
- At 2 minutes, a solution of succinate, a Krebs cycle intermediate, was injected through the seal.
- At 5 minutes, a solution of ADP was injected through the seal.
- At 6 minutes, a solution of cyanide was injected through the seal.

During this procedure the oxygen concentration in the chamber was measured continuously and displayed as a trace on the computer screen as shown in Fig. 2.2.

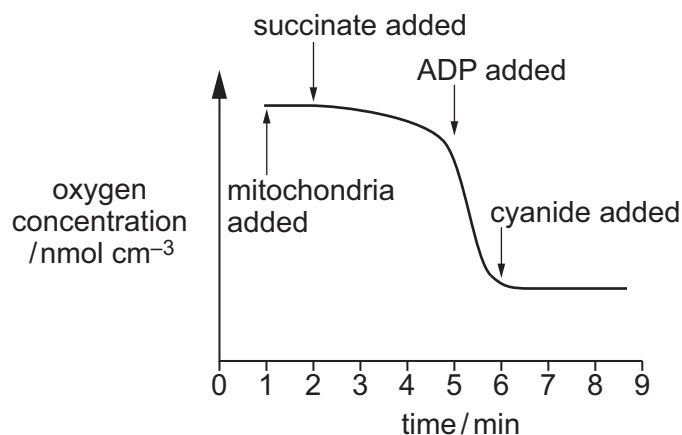


Fig. 2.2

Using the figures from the trace, the computer calculated the rate of oxygen consumption following each addition. This procedure was repeated three more times using fresh samples of mitochondria.

Table 2.1 shows the rates of oxygen consumption for each of the four trials.

Table 2.1

	rate of oxygen consumption / nmol min^{-1}				
	trial 1	trial 2	trial 3	trial 4	mean
mitochondria alone	0.03	0.02	0.03	0.01	0.02
mitochondria with succinate	50.22	49.10	48.53	50.15	
mitochondria with ADP and succinate	139.23	170.10	142.67	138.10	147.53
mitochondria with cyanide, ADP and succinate	0.00	0.10	0.00	0.01	0.03

- (b) (i) Calculate the mean rate of oxygen consumption for mitochondria with succinate.

Write your answer in Table 2.1.

[1]

- (ii) On Table 2.1 indicate, by placing a circle around each value, **two** results that may be anomalous.

[2]

- (iii) State **two** ways that the student could have processed the results to allow for these possible anomalies.

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..... [2]

(c) Explain the results shown in Fig. 2.2 and Table 2.1.

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..... [3]

[Total: 9]